DOE PROJECT OVERVIEW

RESEARCH AND DEVELOPMENT AND ANALYSIS FOR ENERGY EFFICIENT TECHNOLOGIES IN TRANSPORTATION AND BUILDING APPLICATIONS

SUBTOPIC 1.A.1 AND 1.A.2

DEVELOPMENT OF IMPROVED CATHODE CATALYSTS AND HIGH TEMPERATURE MEMBRANES

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OBJECTIVE

TO DEVELOP AND DEMONSTRATE ADVANCED Pt ALLOY CATHODE CATALYSTS AND A POLYMERIC MEMBRANE ABLE TO OPERATE AT NEAR AMBIENT PRESSURE (1-1.5 ATM) IN THE RANGE OF 120°C TO 150°C THAT MEETS DOE'S PROJECT GOALS

DOE GOALS

Performance (0.5A/cm^2), V	0.77 (ambient P)
Loading, mg Pt/cm^2	0.05
MEA Cost, $/kW	10
Operating Temperature, °C	120-150
Power Density (0.80V), W/cm^2	0.320

FUNDING, DURATION AND DELIVERABLES

Total Funding: 9.5M$
DOE Share: 7.6
Cost Share: 1.9

Duration: 4 Yrs.

Deliverable: Selected laboratory scale MEAs and a full scale stack containing final selected high-temperature membrane will be delivered to Argonne National Laboratory after completion of testing at IFC

PARTICIPANTS AND PI's

HIGH TEMPERATURE MEMBRANES

IFC: Drs. Patrick Hagans/Shyam Kocha
VA Tech: Dr. James McGrath
IONOMEM: Mr. Leonard Bonville
Penn State: Dr. Digby MacDonald
SRI: Dr. Subhash Narang
Princeton: Dr. Andrew Bocarsly

IMPROVED CATHODE CATALYSTS

IFC: Dr. Patrick Hagans
NEU: Dr. Sanjeev Mukerjee
U.S.Carolina: Dr. Branko Popov
UTRC: Dr. Thomas Jarvi
CWRU: Dr. Alfred Anderson

PROJECT DESCRIPTION

PHASE 1. CATALYST AND MEMBRANE DEVELOPMENT

Pt alloy catalysts will be modeled, synthesized and characterized. The activity of cathode catalysts will be determined and optimized. Requirements for membranes will be specified and various membranes will be synthesized and characterized. Comparison of candidate membranes against specifications will be made.

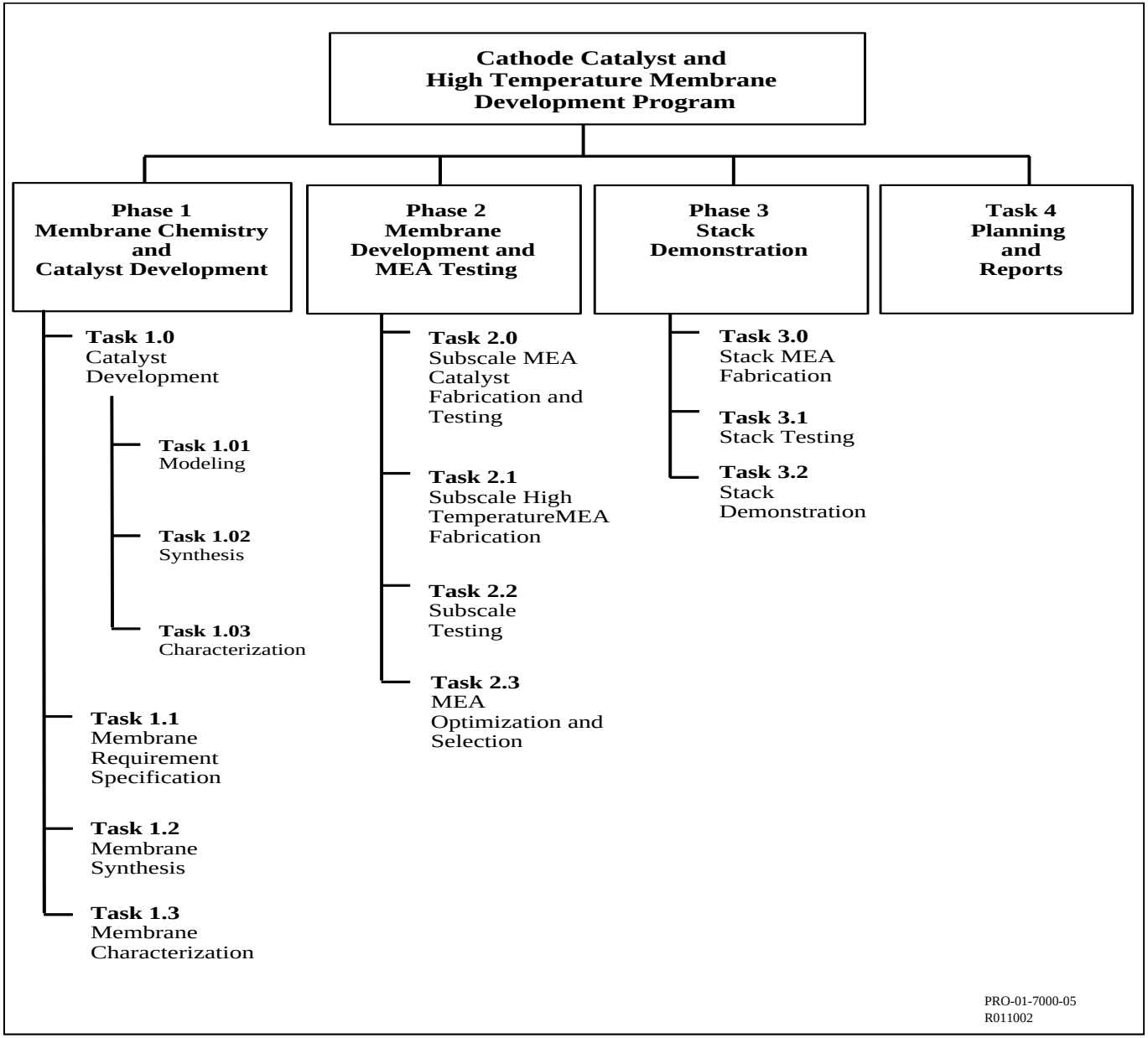
PHASE 2. MEA FABRICATION AND TESTING

Membrane Electrode Assemblies (MEAs) will be fabricated and tested using selected catalysts on the laboratory scale. The same will also be done with selected high temperature membranes. Down-selected catalysts and membranes will be optimized and tested on the laboratory scale.

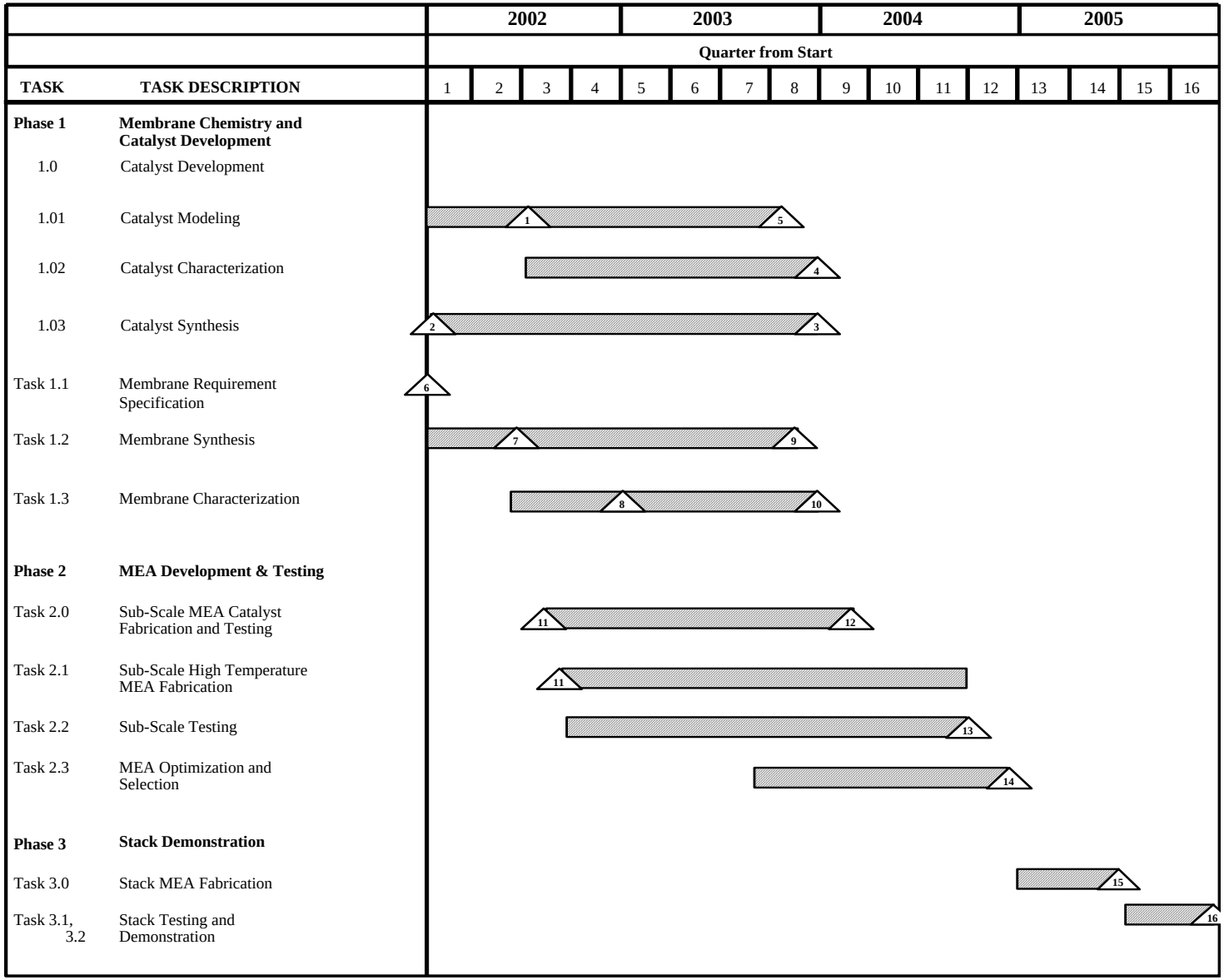
PHASE 3. STACK TESTS

Down-selected membranes and catalysts will be fabricated into full size MEAs for demonstration tests in a multi-cell stack.

WORK BREAKDOWN STRUCTURE



PERFORMANCE SCHEDULE



MILESTONE SCHEDULE

PHASE	MILESTONE #	MILESTONE
Phase 1 Membrane Chemistry and Catalyst Development	1 2 3 4 5 6 7 8 9 10	Preliminary model completed Begin alloy synthesis Complete alloy synthesis Complete characterization and down-selection Complete modeling + correlation Membrane specification to team members Initial sample membrane Characterization of initial membrane samples Synthesis of final membrane samples Select membrane for Phase 2
Phase 2 MEA Development and Testing	11 12 13 14	Initial electrode fabrication Complete subscale testing for cathode catalyst and down-select catalysts Complete subscale testing for membranes and down-select membrane(s) Select optimum catalyst-membrane combination for Phase 3
Phase 3 Stack Demonstration	15 16	Complete stack and test stand assembly Complete stack verification test

CONTRACTOR TASKS

IFC: Synthesis of ternary Pt alloys by carbothermal reduction methods; alloy characterization, MEA construction and testing at the sub-scale, full scale and full-scale short stack levels

NEU: Synthesis of binary and ternary alloys using a micelle approach; *in situ* characterization of structure and electronic properties by XAS

CWRU: Modeling studies based on density functional slab band calculations of O_2, H_2O and OH adsorption on simple Pt-M alloys and selected ternary alloys

USC: Synthesis of binary and ternary Pt alloys by depositing metal from a colloidal suspension and pulsed electrodeposition

VATECH: Synthesis of biphenol based aromatic poly(arylene ether) sulfones containing pendant sulfonate groups

CONTRACTOR TASKS

Penn State: Synthesis of 1)acid functionalized polyelectrolytes (*e.g.*, PBI, PEEK, PBP and PVA), 2)PBI/H_3PO_4, H_2SO_4 and PVA/H_3PO_4 and 3) acid functionalized aliphatic sulfones and sulfoxides

Princeton: Synthesis of layered structures consisting of an inner core of sulfonated-PS/inorganic composite and outer layers of perfluorinated polymer

IONOMEM: Incorporate solid H^+ conductors such as phospho-tungstic acid or Zr hydrogen phosphate into Nafion™

SRI: Synthesis of sulfonated polyetheretherketones with controlled degree of sulfonation and blend with imidazole-functionalized polyethers and PAN